becomes human with all the great distinctions of that term.

ANTHROPOMETRICAL TESTS.

SINCE Mr. Francis Galton conducted his anthropometrical measurements at the International health exhibition, increased attention has been given to the measurement of physical characteristics and of the senses. Mr. Galton has received letters from Tokio, from Rome, from Paris, and elsewhere, asking for the necessary apparatus for establishing a laboratory where the important measurements of the body and testing of the senses can be made.

The importance of such observations is well understood. It will enable us to determine accurately racial characteristics, to mark the stages of individual growth, to detect abnormalities of development in time to check them, to lay the foundation for a rational education of the senses and the muscles.

Mr. Galton has been devoting much time to the preparation of instruments for measuring the head and the delicacy of the senses; and Mr. Horace Darwin, of the Cambridge scientific instrument co., has aided him in the work. The last Journal of the Anthropological institute of Great Britain contains a preliminary account of some of their devices.

As regards the size of the head, it is well known that the caps of university students are larger than those of the uneducated population. With a convenient method of determining the size of the head in various directions, one could find at what age generally and individually the growth of the brain comes to a standstill. The method of taking the measurements is still a matter of controversy. The maximum breadth can be gotten by a pair of calipers, with rough teeth, like those of a comb, to penetrate the hair. The maximum length from the glabella (the central point between the eyebrows) is also easy to measure. The great difficulty is in getting the height of the head. Mr. Darwin's instrument for this purpose is inserted into the two ear-holes, and a slight projection is caught by the inner edges of the orbits: this determines the horizontal plane, and measurements are taken to either side from it. He will improve the instrument by having a band attached, to be inserted under the chin, and thus press the frame close against the orbit.

For the color of the eyes and hair, Mr. Galton suggests, instead of printed shades, which are apt to fade, small disks of colored glass for the eyes, and spun threads of this glass for matching the hair.

The usual form of dynamometer for measuring the force of one's grip is objectionable, because the maximum clutch depends on the width and convenience of the instrument at its widest point. Mr. Darwin is making an instrument to avoid this defect.

With regard to sight, Mr. Galton admitted that there was no good recognized way of measuring the acuteness of vision, but thought the simple method of getting the distance at which one can tell in what corner of a white card a black dot is to be found, as good as any. Mr. Brudenell Carter, who has published some interesting views on the relation of eyesight to civilization, objected to this method, and preferred the test of distinguishing two closely adjoining dots. There are many good methods of testing the color-sense; and Dr. Cattell's experiments at Leipzig, on the time it takes to perceive the various colors, are of interest here. He found that it requires 8 ten-thousandths of a second to see orange, 10 to see yellow, 12 to see blue, 13 to see red, 14 to see green, 23 to see violet. The exposure was made by an arrangement similar to the instantaneous shutter of a camera. Great individual differences in the perception of various colors appeared, and a simple form of his apparatus might be useful for testing the color-sense.

With regard to sounds, we have almost no exact methods of measuring. The susceptibility to pitch can be readily measured.

Mr. Darwin also exhibited before the Anthropological society an ingenious contrivance for measuring one's reaction time, which works on the principle of snapping a rod, and arresting it in its fall as soon as possible after the sound is heard.

The subject is really one of the highest practical importance, and physiological as well as mechanical problems are involved. A physiologist with a mechanical bent would certainly find here a fruitful field.

THE STUDY OF THE SENSES.

THE great name of Helmholtz stands for the union of the physical and biological sciences. The late Professor Clifford speaks of him as "the physiologist who learned physics for the sake of his physiology, and mathematics for the sake of his physics, and is now in the first rank of all three." In his 'Physiological optics' and his analysis of the 'Sensations of tone,' he gave to the world two classical works, as invaluable to the physicist as to the psychologist and physiologist. The real greatness of these studies, the new engine that he employed, consisted in recognizing the dual nature

of all phenomena, and attacking his problems from both points of view. To the physicist a body is a piece of matter exhibiting certain properties under certain conditions : to the psychologist it is a complex of sensations. For many purposes it is advisable to keep these things separate. But the convenience arising from this separation gave rise to the false notion that the two things had little or nothing in common, and, if useless metaphysical questions were to be avoided, had better have little in common. It was an example of over-specialization. Helmholtz showed, that, apart from any metaphysical notions or discussions, a large common field lay open, where the combined forces of physics and psychology could and ought to unite to shed new light on a most important department of scientific research.

Helmholtz was not long without followers in his rich line of work, and foremost among these is Professor Mach of the University of Prague. He, too, is a physicist, but was constantly driven to a study of the senses by the wide point of view from which he regarded his science. He is best known as a psychologist by his study of the sensations accompanying motion. In these he contrived an ingenious apparatus by which persons were swung around in various directions, and the inference drawn from the nature of the vertigo caused by the revolutions, that the semicircular canals of the internal ear, which experiments on animals had shown to be a mechanism for maintaining equilibrium, served a similar function in man. He has also repeated and added to the analysis of tone sensations which Helmholtz made. His work is characterized throughout by an unusual ingenuity, great accuracy, and a clear and easy exposition.

In a recent publication [1] he has added some highly suggestive studies in the sphere of sight and hearing, and accompanied them by a statement of the point of view from which he regards the study of the senses. It is to the latter that attention is to be briefly called.

" Through the deep conviction that science in general, and physics in particular, is to expect the next great advancements with regard to its fundamental position from biology, and more especially from the analysis of sensation, I have been repeatedly drawn into that field." This the opening sentence of his preface may be regarded as a text. Before proceeding with his argument, he wants to clear the ground by a few ' anti-metaphysical ' remarks. In the first place, as to what a thing is. It is what can be perceived by the mind at once : it is this that gets a name. An apple is a complex of visible, tangible, smellable, tastable qualities. One's self is a more constant complex of such and other sensations associated with the body. By a comparison of various such complexes of sensations, we analyze them, and divide off the visible, tangible, etc. The visible, again, we divide into form and color, and these are our elements. The body is only the sum of the sensations to which it can give rise. The illusion that because we can abstract each of these sensations separately, and still retain the body, we can do so with all at once, has given rise to the metaphysical ' thing *per se*.' The chasm between physics and psychology exists only in our stereotyped mode of presentation. A color is a physical object when we consider its dependence on the source of light, its relation to other colors, its heat-giving properties, etc. : it is a psychological object when we consider its dependence on the retina. In the first case we trace a relation between two series of phenomena : in the second case one of the series is replaced by a third, of different nature. It is the point of view that makes the difference. We avoid the conflict between the physical and psychological points of view by considering sensations as the ultimate elements. This, too, is not to be regarded as the permanent, but, as for present purposes, the most economical position.

The sensation, in turn, can be subjected to a psychological analysis, can be regarded as a physical (physiological) phenomenon, or its dependence on physical processes worked out. The latter, whenever possible, is the ideal goal to be reached. Our guiding principle is that of a complete parallelism between the psychic and the physical. At times, it is true, more light will be gotten from a purely biological (evolutionary) point of view ; but this, again, can be formulated under the general rule.

The advantages that physics is to gain from such considerations are many. In the first place, a false conception is eradicated. There is no subject and object, no thing and sensation. Only one kind of elements exists, from which subject and object are built up. The ' sensible ' world is the common property of physics and psychology. It is physics as long as we disregard our own body : it is psychology when that is the special object of research. Again, the physicist will no longer be misled by such imposing entities as matter, atoms, etc. He will recognize their purely secondary and symbolical origin.

An adaptation of our method of thinking to the facts is the end of science. This goes on unconsciously in the daily life of every one : it is education. When raised into a conscious and deliberate object, it becomes scientific research. If

[1] *Beitrage zur analyse der empfindunger*. VON DR. E. MACH. Jena, 1886.

the facts of nature really are as here represented, the gaining of this new point of view must be regarded as a distinct advance in this adaptation.

From the above unsatisfactory [1] sketch of Professor Mach's position, it may perhaps be seen that he regards a great psychophysic movement in science as the next revolutionary process. Many signs of such a movement are already evident.

J. J.

A MANUAL OF NORTH AMERICAN BUTTERFLIES.

ALTHOUGH a really good manual of our butterflies has long been a desideratum, Morris's Synopsis being altogether out of date, it cannot be said to be supplied in the present work.

The whole aim of the author seems to be to enable his reader to find out the name of a specimen in hand; and to this end his 'analytical key' is fairly good, so far as the perfect insect goes, excepting, that as no tables are given for genera, families, etc., it would not help the student if species not included in the book were to turn up. The key is also faulty, because largely made up of very unimportant characters, and because it takes no account of the earlier stages; indeed, no means whatever are anywhere furnished for finding out the affinities of a caterpillar or chrysalis in hand, except by wading through all the descriptions in the book.

We fail to see how the work can be of any possible pedagogical service, although this is claimed as its chief end. For, first, the only clew it gives to the classification, i.e., the natural arrangement of butterflies, is in the brief statement that is presented of the characters of some of the higher groups, and, incidentally, in the actual arrangement of the species treated; there is scarcely a reason suggested why the sequence of the groups should be as it is; it is simply stated in the preface that Edwards's arrangement is followed, yet Edwards has never offered a reason, but only printed a bare list. Second, the arrangement itself is unnatural, holding its ground only through precedent, as a legacy from the less-informed authors of fifty years ago. Third, the whole aim of the author appears to be to enable the user to answer the question, 'What is the *name* of my butterfly?'— for pedagogical purposes not even a worthy, far less the best end.

The genera are nowhere characterized; the descriptions of the butterflies could be much improved by more concise and methodical expression and the italicizing of the most distinctive features; the early stages of a considerable number of species are omitted, when they have been known and published for many years; and, finally, there is not a line or suggestion throughout the book which would lead one to suspect that science had changed within the last eventful quarter-century. It is but the rehabilitation of the dry husks of a past generation.

[1] The account is perhaps unavoidably so; as it was the task of the reviewer to avoid the technicalities of the psychological part on one side, and of the physical part on the other.

The butterflies of the eastern United States, for the use of classes in zoölogy and private students. By G. H. FRENCH. Philadelphia, *Lippincott*, 1886. 12°.

SCRANTON is the centre of what is known as the northern anthracite coal-field of Pennsylvania, comprising nearly two hundred square miles. Using this fact as a fulcrum, and taking for a lever the fact that natural gas has to a great extent displaced coal in Pittsburgh, the Scranton board of trade are endeavoring to lift their home into prominence as one of the great manufacturing cities of the future. In a neat pamphlet recently published by the board, it is pointed out that gas is a more economical fuel than coal; that the supply of natural gas will soon be exhausted; that there are forty million tons of culm, or coal-waste, — which may be had for the taking, — lying about the mines of the Scranton region; that this amount is being increased by two million tons annually; that gas may be made from this waste at a cost of two cents per thousand feet; that in the near future coal will probably be converted into gas in the mines, and piped to the surface; that gas-engines are steadily growing in favor; and that Scranton is already a great railway centre, with excellent shipping facilities to all points of the compass. The conclusion is inevitable, at least to the publishers of the pamphlet, that Scranton is a very desirable place for the establishment of industries requiring cheap fuel and power.

— An experiment with a new hydro-carbon fuel burner for locomotives was recently tried on the Third Avenue elevated railroad in this city. The burner is about six inches in length by five in diameter. A spray of petroleum and steam was forced through perforations in the burner, producing a large volume of flame; but, through inability to control the draught of the furnace, combustion was imperfect, and the experiment was a failure. This was only one of a long series of experiments with similar devices, none of which has succeeded. As the consumption of coal on the locomotives of the elevated railroads averages only two and six-tenths pounds per horse-power developed, there would seem to be no field for the economic substitution of petroleum at present prices.